CLAIMS

1. A hydrothermally stable alumina support comprising a transition alumina and at least one modifying agent comprising an element from the Periodic Table with an atomic volume between about 6 and about 14 cm^3/mol, wherein a precursor of the at least one modifying agent is deposited onto the transition alumina.

2. The hydrothermally stable alumina support of claim 1, wherein the atomic volume of the element is between about 9 and about 11 cm^3/mol.

3. The hydrothermally stable alumina support of claim 1, wherein the transition alumina comprises gamma-alumina.

4. The hydrothermally stable alumina support of claim 1, wherein the element is aluminum.

5. The hydrothermally stable alumina support of claim 4, wherein the at least one modifying agent comprises the form of a hydroxide, an ion, or mixtures thereof.

6. A process for stabilizing a high surface area alumina support, wherein the process comprises:

(A) providing an alumina precursor;

(B) depositing a modifying agent comprising an element from the Periodic Table with an atomic volume between about 6 and about 14 cm^3/mol onto the alumina precursor; and

(C) calcining the alumina precursor to form a hydrothermally stable modified alumina support.

7. The method of claim 6, wherein the alumina precursor of step (A) comprises one or more transition alumina phases.

8. The method of claim 7, wherein the alumina precursor of step (A) comprises one or more transition phases selected from gamma, delta, kappa, eta, chi, rho, and theta.

9. The method of claim 6, wherein step (A) further comprises pre-treating the alumina precursor.

10. The method of claim 9, wherein pre-treating comprises spray drying, dehydrating, drying, steaming, or calcining.

11. The method of claim 6, wherein step (A) further comprises dispersing the alumina precursor in a solvent to form a sol.

12. The method of claim 11, wherein depositing the modifying agent onto the alumina precursor of step (B) further comprises depositing the modifying agent onto the sol.

13. The method of claim 12, wherein the sol is spray dried after depositing the modifying agent onto the sol.

14. The method of claim 6, wherein step (B) is accomplished by spray-drying, impregnation, co-precipitation, or chemical vapor deposition, or plasma sputtering.

15. The method of claim 14, wherein impregnation comprises incipient wetness impregnation.

16. The method of claim 6, wherein the modifying agent of step (B) comprises aluminum.

17. The method of claim 6, wherein the modifying agent of step (B) comprises an aluminum salt, dispersible boehmite, dispersible pseudo-boehmite, or mixtures thereof.

18. The method of claim 17, wherein step (C) is accomplished at temperatures from about 250 °C to about 900 °C.

19. The method of claim 6, wherein step (B) further comprises depositing at least one additional modifying agent onto the alumina precursor.

20. The method of claim 6, wherein step (C) is accomplished at temperatures between 500 and 900 °C.

21. The method of claim 20, wherein the atomic volume of the element is between about 8 and about 12 cm^3/mol.

22. The method of claim 21, wherein the atomic volume of the element is between about 9 and about 11 cm^3/mol.

23. The method of claim 6, wherein the hydrothermally stable alumina support comprises an oxide of the element, and wherein the element oxide has a molecular volume lower than that of aluminum oxide.

24. The method of claim 23, wherein the element oxide has a molecular volume between about 10 and about 25.7 cm^3/mol.

25. The method of claim 6, wherein the alumina precursor comprises gamma-alumina.

26. The method of claim 6, wherein step (B) is accomplished by impregnation.

27. The method of claim 6, wherein step (C) is accomplished at temperatures between about 800°C and about 900°C.

28. A catalyst comprising a catalytically active metal on an aluminum-modified alumina support, wherein the aluminum-modified alumina support comprises at least one modifying agent comprising aluminum.

29. The catalyst of claim 28, wherein the aluminum-modified alumina support is made by a method comprising impregnating a precursor of the at least one modifying agent comprising aluminum to an alumina precursor.

30. A catalyst of claim 29, wherein the precursor of the at least one modifying agent comprising aluminum comprises an aluminum ion, a hydroxide of aluminum, or combinations thereof.

31. The catalyst of claim 30, wherein the precursor of the at least one modifying agent comprising aluminum comprises aluminum nitrate, aluminum lactate, aluminum acetate, or combinations thereof.

32. A catalyst of claim 29, wherein the alumina precursor comprises a transition alumina.

33. The catalyst of claim 29, wherein the alumina precursor comprises gamma-alumina.

34. The catalyst of claim 28, wherein the catalytically active metal comprises at least one metal selected from the group consisting of cobalt, ruthenium, iron, nickel, and combinations thereof.

35. A method for producing hydrocarbons, comprising:

(A) providing a reactor having a catalyst comprising an aluminum-modified alumina support; and

(B) contacting a reactant gas comprising carbon monoxide and hydrogen with the catalysts to produce the hydrocarbons.

36. The method of claim 35, wherein the hydrocarbons comprise primarily at least 9 carbons.

37. The method of claim 35, wherein the aluminum-modified alumina support of step (A) comprises an alumina support modified by at least one modifying agent comprising aluminum.

38. The method of claim 37, wherein the alumina support is modified by at least one modifying agent comprising aluminum by applying a modifying agent precursor comprising aluminum nitrate, dispersible boehmite, dispersible pseudo-boehmite, or mixtures thereof.

39. The method of claim 37, wherein the alumina support is further modified by at least one additional modifying agent.

40. The method of claim 35, wherein the catalyst comprises at least one promoter selected from the group consisting of platinum, palladium, ruthenium, rhenium, silver, boron, copper, lithium, sodium, potassium, magnesium, and combinations thereof.

41. The method of claim 35, wherein the catalysts of step (A) comprise catalytically active metal comprising at least one metal selected from the group consisting of Group VIII metals, Group IX metals, Group X metals, molybdenum, rhenium, and tungsten.

42. The method of claim 35, wherein the catalysts of step (A) comprise catalytically active metal comprising at least one metal selected from the group consisting of cobalt, ruthenium, iron, nickel, and combinations thereof.

43. The method of claim 35, wherein the reactant gas of step (B) contains hydrogen and carbon monoxide in a molar ratio of from about 0.67:1 to about 2.5:1